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THE EFFECTS ON FORAGE QUALITY OF PELLETING BY USING DIFFERENT ADDITIVES OF SUGAR BEET HEAD AND LEAVES

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Abstract

This study was carried out with the aim of determining of using sugar beet head and leaves (SBHL) pelleted with different additives in ruminant nutrition. In this study, two feed types (pelleted-granulated) were used and four treatment groups (control, urea (2.5%), molasses (7%) and urea+molasses (2.5%+7%) were formed. The nutrient contents, relative feed values (RFV) and in vitro true digestibilities (IVTD) were determined in all groups. The randomized parcels experimental design was used in statistical analysis. In present study, it was determined that fresh form had higher nutritive value and also all the groups had higher RVF and forage quality. Furthermore, it was determined that pelleted form with molasses addition had higher forage quality for all the forms except for fresh form and pelleting had positive effect on IVTD. It was concluded that dried SBHL could be used as forage source in animal nutrition that use of additives increased the feed value and that pelleting had positive effetcts.

Keywords: Sugar beet head and leaves, Pellet, Digestibility, Molasses, Urea, Relative feed value

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1. Introduction

Forages play an important role in the physiology of the digestive system of ruminants (Budak and Budak, 2014). It is possible to replace a certain part of the concentrate feed with forages if they are high quality and affordable, which allows for economical stock farming. In Turkey, several types of agricultural waste, industrial waste, pulp, etc. can be used to close the gap in quality forage which adds up to 30 tons annually. It is estimated that the world's annual sugar beet production is around 230 million tons (FAO, 2016) and the post-harvest waste (sugar beet head and leaves: SBHL) can be used as a source for animal feed (Ak and Uzatıcı, 2001). Today, it is a common practice to disperse the SBHL chopped by machines back into the field as fertilizer following the sugar beet harvest. The financial benefit of using the harvest waste of sugar beet in animal farming is 5 to 6 times more than that of its use as fertilizer. It is recognized as an alternative forage source, SBHL is used in fresh, dried and ensiled forms. Care should be taken to the low dry matter content and cleaning of the leaves when ensiling the post-harvest waste of sugar beet. Otherwise, the bacterial contamination level is increased with the introduction of soil (butyric acid) which makes it difficult for ensilage (Kilic, 1986; Can et al., 2003; Kutlu and Celik, 2014).

On an average, heads and leaves of sugar beet contain 13-20% dry matter, 2-3% crude protein, 0.4% crude fat, 4-10% crude ash, 8.2% nitrogen free extracts, and 2.5% crude fibre and it is digested at a high level by ruminants (Karabulut, 2002; Kutlu and Celik, 2014). The fact that heads and leaves of sugar beet contains saponin and oxalic acid limits the SBHL consumption by animals and may lead to digestive disorders such as *diarrhea* when consumed in increased amounts. Nevertheless, pelleting process is capable of eliminating such disadvantages with the benefits it has to offer (Karabulut, 2002; Kutlu and Celik, 2014; Gulecyuz and Kilic, 2016). As the materials have a DM content approximately at the level of 85%, SBHL needs to be dried when it is pelleted (Gulecyuz and Kilic, 2016). Doing this will eliminate the effects of nitrate and other harmful substances available in the leaves of the plant. Also considering the benefits of additives, it is believed that pelleting will improve the forage value of SBHL.

The purpose of this study was to increase the nutrition value of SBHL with the addition of molasses and urea, which is believed to contribute in closing the gap in forage supply; and to define the effects of pellet forms on the nutritional value, forage quality and digestibility under in vitro conditions. This study was designed with the hypothesis of pelleting SBHL increases the forage value and digestibility of SBHL.

2. Material and Method

In the experiment it was used aproximately 250-300 kg sugar beet head and leaves (SBHL) collected after harvest from 3 different locations in Amasya Province of Turkey (420 m altitude, 40°5701' latitude (N) and 35°7309' longitude (E)) in November 2014. Fresh materials were dried in a forced-air oven at 65°C for 72 hours. The remaining fresh materials were dried in a room temperature condition in the laboratory.

2.1. Establishment of treatment groups

After being dried and ground to a size able to pass through 4mm sieve. Urea and sugarbeet-molasses were used as additives in order to increase the nutrient contents of SBHL. Sugar beet head and levaes groups are named as follow; Fresh (natural form after harvest), G-Control (No additives-granule form), P-Control (No additives-pelleted form), G-Urea (Supplemented urea 2.5%-granule form), P-Urea (Supplemented urea 2.5%-pelleted form), G-Molasses (Supplemented molasses 7%-granule form), P-Molasses (Supplemented molasses 7%-pelleted form), G-Urea+Molasses (Supplemented molasses 7%+urea 2.5%-granule form), P-Urea+Molasses (Supplemented molasses 7%+urea 2.5%-pelleted form). In this study, 9 groups for SBHL were formed for 2 form applications (granule-pellet form) and 4 treatments (control, urea, molasses and urea+molasses). Additives and SBHL's samples were homogeneously mixed together. Then, each group was pelleted in 6 mm diameter pellets or granule form with replication.

2.2. Chemical compositions of samples

The samples were ground with mill through (1 mm) sieve for chemical composition analysis. Then all the samples were analyzed for crude protein (CP), dry matter (DM) and ash contents were analyzed according to AOAC (1998). Crude fibre (CF), acid detergent lignin (ADL), acid detergent fibre (ADF) and neutral detergent fibre (NDF) analysis were done according to methods of Van Soest et al. (1991) using Ankom 2000 Fiber Analyzer. Ether extract (EE) content was analyzed using Ankom XT15 Extraction System according to AOCS (2005). Hemicellulose, cellulose and nitrogen free extracts contents were determined by calculation.

2.3. Determining in vitro true digestibilities of samples

In in vitro experiment, rumen fluid was obtained from two Jersey x Native Black bulls (avarage 500 kg liveweight and 2.5 years old) just after slaughtered at slaughterhouse. After straining the rumen fluid into a thermos at 39 °C under carbon dioxide through two layers of cheesecloth, approximately 100 g of rumen solid content was added and transported to the laboratory within 20 minutes. The thermos was transported to the laboratory within 20 minutes. The in vitro true digestibility (IVTD) of the samples was determined by using Ankom Daisy incubator (filter bag system) according to Van Soest et al (1991) and Ankom (2002) procedures. Daisy incubator instrument contains 4 cylinder jar which each cylinder jar need 1600 ml buffer solution and 400 ml rumen content as inoculums and filter bags. The jars was bubbled with carbondioxide immediately before closed with of jar. After 48 hours of incubations, filter bags were cleaned under water flow and dried. Then, the bags was analyzed for neutral detergent fibre digestibility. In vitro true digestibilities of samples were estimated as follows;

In Vitro True Digestibility (IVTD) % =100 - ((W3 - (W1 × C1)) × 100)/W2

Where: W1: Weight of filter bag, W2: Weight of sample, W3: Final weight after NDF analysis, C1: The bag without sample was prepared also for correction.

2.4. Determining pH, volatile fatty acid (VFA) and

ammonia nitrogen (NH3-N) analysis in rumen fluid

Rumen pH values were determined using in rumen fluids immediately after bringing to the laboratory by using digital pH-meter (Hanna Ins.1332) in three replicates. The total volatile fatty acid (TVFA) and NH3-N analysis were done according to Markham (1942) in three replicates.

Determining relative feed values of samples: The relative feed value (RFV) of SBHLs were calculated as follows (Rohweder et al. 1978);

DMI= Dry matter intake (Live Weight= LW %)= 120 / (NDF%)

DMD= Dry matter digestibility (%)= 88.9 – (0.779 × ADF%)

RFV= Relative feed value= (DMD × DMI) / 1.29

2.5. Statistical analysis

The data obtained from the experiments were analyzed in accordance with the randomized parcels experimental design. SPSS 20.0 software package program (Ondokuz Mayis University Licensed Programme Samsun-Turkey) was used in the statistical analyses of the observations. Duncan's multiple range test was used for the comparison of mean values.

3. Results and Discussion

3.1. Chemical Compositions of Samples

Nutritional contents of the forages tested in the experiment are shown in Table 1. Accordingly, no statistically significant difference was found between the forages in terms of their OM, EE and ash content (P>0.05). In terms of their crude protein contents, the highest value was obtained from the granulated forage with urea (p<0.001), where pelleting did not have any influence on the CP content of other forages. Pelleted group with urea was found to have significantly lower CP content (p<0.001) compare with granulated groups. It is believed that gases in the form of ammonia due to the heat generated in the pelleting process may account for such decrease. Indeed, the fact that the decrease observed in the case of urea+molasses addition was insignificant may be a result of the breakdown of proteins during pelleting when urea, solely, is added to SBHL.

Can et al. (2003) added 0.5% and 5% molasses to fresh material and reported their CP content as 25.33% and 21.05%, respectively. These figures were lower than the findings of the study, which added 2.5% and 7% molasses to the dried SBHL material (29.22% and 19.31, respectively). Considering the fact that authors used the additives with fresh material, it can be said that the results are similar.

Fresh SBHL was found to have the lowest CF content among the other feeds tested. Feed with high fiber content most commonly offer lower forage value. Thus, high CF content in feed is not something desirable. In the experiments, it was found that pelleting reduced the CF content of the control group and the group with urea when compared to that of the granulated forms (p<0.001), while the groups with molasses and urea+molasses was not found to have a statistically significant difference.

Fresh form SBHL was the one with the highest NFE (Nitrogen free extracts) content (p<0.001), and the lowest NFE content was found in the urea added forage in the granulated form, as expected. It was also found that urea addition increases the NFE content in all the granulated forms offering the lowest values after pelleting (p<0.001).

Fresh form SBHL was found to have the lowest NDF content. Therefore, it can be said that fresh form is the one that will be consumed with more appetite. The only difference in NDF content was found between the granulated form control group and the pelleted form with molasses (p<0.001). The NDF contents found in this study were higher than those reported by Can et al. (2003) for silages (27.24-34.54%) prepared using sugar beet leaves and salt, formic acid, urea, molasses and broken wheat as additives. In general, it is believed that the silages prepared using SBHL will be insufficient in terms of its fiber content when consumed as the sole forage source, however, after being dried or pelleted, it can be a sufficient forage source in meeting the fiber needs of the ruminants.

The lowest ADF value was found from the fresh form forage while the highest ADF content was found in the pelleted form of urea added forage. Furthermore, there was no statistically significant difference between the other forages (P>0.05). In addition, it was observed that the addition of urea to SBHL significantly increases the ADF content (p<0.001). Among the forages in this study, the lowest ADL content was found in fresh form, granulated form control group and pelleted form with molasses (p<0.001), while the other forages consistently gave higher ADL contents. It was found that ADL content increases with the pelleting of the control group and urea and pelleting the forage with urea and urea+molasses. This finding was statistically important (p<0.001).

Nutrient contents of the forages included in this study are found to be in agreement with those reported in the literature (Karabulut, 2002; Kutlu and Celik, 2014). However, some of the findings of this study are not in agreement with the literature. This difference may be ascribed to several factors such as the difference in subspecies, the content of the soil used and the difference in harvest time (Kilic and Saricicek, 2006;

Kilic, 2010).

Table 1. The effects of additive use in SBHL on their chemical content, DM%

	DM*	OM	CP	EE	CF	ash	NFE	NDF	ADF	ADL	HCEL	CEL
Fresh	26.68 ± 0.25^{d}	73.75 ± 1.05	19.25 ± 0.16^{c}	1.62 ± 0.21	31,47 ± 2,42^{a}	26.25 ± 1.05	21,42 ± 1,87^{d}	33.15 ± 0.55^{c}	19.73 ± 0.37^{c}	9.25 ± 0.45^{d}	13.42 ± 0.19^{d}	10.48 ± 0.09^{d}
G-Control	91.52 ± 1.07^{ab}	74.25 ± 1.20	19.48 ± 0.12^{c}	1.39 ± 0.10	17,97 ± 0,29^{b}	25.75 ± 1.20	35,41 ± 1,46^{ab}	46.68 ± 0.90^{a}	24.82 ± 0.35^{b}	9.31 ± 0.47^{d}	21.87 ± 0.61^{a}	15.51 ± 0.18^{a}
P-Control	89.77 ± 0.03^{bc}	71.41 ± 2.11	19.01 ± 0.03^{c}	2.03 ± 0.20	13,71 ± 0,86^{cd}	28.59 ± 2.11	36,67 ± 2,78^{ab}	43.86 ± 0.30^{ab}	25.49 ± 0.71^{b}	10.78 ± 0.41^{c}	18.37 ± 0.49^{c}	14.71 ± 0.31^{b}
G-Urea	93.60 ± 0.05^{a}	72.08 ± 0.50	29.22 ± 1.10^{a}	1.17 ± 0.15	16,13 ± 0,55^{bc}	27.92 ± 0.5	25,57 ± 1,28^{cd}	46.60 ± 0.85^{a}	25.61 ± 0.45^{b}	11.45 ± 0.41^{bc}	20.98 ± 0.48^{ab}	14.17 ± 0.18^{b}
P-Urea	89.83 ± 0.14^{bc}	74.33 ± 0.06	27.74 ± 0.15^{b}	1.60 ± 0.35	12,82 ± 0,55^{d}	25.67 ± 0.06	32,17 ± 0,33^{b}	46.44 ± 0.49^{a}	26.96 ± 0.41^{a}	13.46 ± 0.35^{a}	19.47 ± 0.90^{bc}	13.50 ± 0.06^{c}
G-Molasses	93.49 ± 0.14^{a}	74.62 ± 0.43	19.31 ± 0.28^{c}	1.25 ± 0.10	17,15 ± 0,65^{b}	25.38 ± 0.43	36,90 ± 0,33^{ab}	45.90 ± 0.38^{ab}	25.03 ± 0.34^{b}	10.71 ± 0.18^{c}	20.87 ± 0.32^{ab}	14.32 ± 0.21^{b}
P-Molasses	89.53 ± 0.12^{bc}	75.10 ± 0.93	19.16 ± 0.13^{c}	1.67 ± 0.57	16,11 ± 0,68^{bc}	24.90 ± 0.93	38,15 ± 0,77^{a}	43.12 ± 1.17^{b}	24.29 ± 0.36^{b}	10.14 ± 0.23^{cd}	18.83 ± 0.81^{bc}	14.15 ± 0.13^{b}
G-Urea+Molasses	92.48 ± 0.07^{a}	70.60 ± 2.44	28.12 ± 0.29^{b}	1.27 ± 0.20	13,98 ± 0,37^{cd}	29.40 ± 2.44	27,22 ± 2,29^{c}	45.07 ± 0.89^{ab}	24.20 ± 0.52^{b}	10.96 ± 0.49^{c}	20.87 ± 0.46^{ab}	13.24 ± 0.35^{c}
P-Urea+Molasses	87.91 ± 0.09^{c}	73.79 ± 0.66	27.34 ± 0.11^{b}	1.85 ± 0.17	11,75 ± 0,58^{d}	26.21 ± 0.66	32,85 ± 0,12^{b}	45.27 ± 0.91^{ab}	25.53 ± 0.06^{b}	12.47 ± 0.05^{ab}	19.73 ± 0.88^{abc}	13.07 ± 0.02^{c}
Significant	<0.001	0.288	<0.001	0.273	<0.001	0.288	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

DM: Dry matter, EE: Ether extract, CP: Crude protein, CF: Crude fibre, NFE: nitrogen free extracts NDF: neutral detergent fibre, ADF: acid detergent fibre, ADL: acid detergent lignin, HCel: Hemicellulose, Cel: Cellulose. P<0.01; a,b,c.: Means with different supercripts in the same column are significantly different. Fresh (natural form after harvest), G-Control (No additives-granule form), P-Control (No additives-pelleted form), G-Urea (Supplemented urea 2.5%-granule form), P-Urea (Supplemented urea 2.5%-pelleted form), G-Molasses (Supplemented molasses 7%-granule form), P-Molasses (Supplemented molasses 7%-pelleted form), G-Urea+Molasses (Supplemented molasses 7%+urea 2.5%-granule form), P-Urea+Molasses (Supplemented molasses 7%+urea 2.5%-pelleted form).

Table 2 shows the DMD, DMI, RFV contents and forage quality classification of the forage used in this study. With respect to their DMD, DMI, and RFV contents, fresh form is found to have the highest values (p<0.001). The lowest dry matter digestibility was found in the pellets prepared with urea, while the rest did not have any statistically significant difference. Pelleting process decreased the DMD value only when compared to granulated form with urea, while the rest did not have any statistically significant difference (P>0.05).It was also found that molasses addition in pellets increases the dry matter consumption when compared to granulated form (p<0.001). There was no finding to indicate an effect of pelleting on RFV. The quality classification with respect to relative forage values, on the other hand, showed that the forages are generally under "Premium" quality class and that the forage value of the pellets prepared with molasses and those in the granulated form are under "Prime" quality class.

Table 2. The effects of additive use in SBHL on forage quality, DM%

	DMD (%)	DMI (%, LW)	RFV	*RFV Quality Class	IVTD
Fresh	73.53 ± 0.29^{a}	3.62 ± 0.06^{a}	206.49 ± 4.17^{a}	Prime	85.34 ± 0.77a
G-Control	69.57 ± 0.27^{b}	2.58 ± 0.05^{c}	138.93 ± 3.15^{c}	Premium	75.64 ± 1.12d
P-Control	69.05 ± 0.56^{b}	2.74 ± 0.02^{bc}	146.48 ± 2.08^{bc}	Premium	80.24 ± 1.17bc
G-Urea	68.95 ± 0.35^{b}	2.58 ± 0.05^{c}	137.75 ± 3.13^{c}	Premium	76.10 ± 0.77d
P-Urea	67.90 ± 0.32^{c}	2.58 ± 0.03^{c}	136.03 ± 0.81^{c}	Premium	80.71 ± 0.88b
G-Molasses	69.40 ± 0.26^{b}	2.61 ± 0.02^{c}	140.66 ± 1.57^{bc}	Premium	75.23 ± 1.75d
P-Molasses	69.98 ± 0.28^{b}	2.79 ± 0.07^{b}	151.21 ± 4.57^{b}	Prime	81.42 ± 0.75b
G-Urea+Molasses	70.05 ± 0.41^{b}	2.66 ± 0.05^{bc}	144.70 ± 3.63^{bc}	Premium	77.06 ± 1.10cd
P-Urea+Molasses	69.01 ± 0.05^{b}	2.65 ± 0.05^{bc}	141.94 ± 2.97^{bc}	Premium	81.96 ± 1.23ab
Significant	<0.001	<0.001	<0.001		<0.001

3.2. A Comparison of the in vitro True Digestibility of the Forages

Properties of the rumen fluid used in the in vitro digestibility experiment are, as follows; pH value 5.72 (5.69 – 5.74); TVFA content 92.24 mmol/l (97.42 – 89.75 mmol/l) and NH_3-N amount 29.90 mg/100 ml (27.64 – 31.22 mg/100 ml). These values confirm that the rumen fluid used in this study had the properties of a standard rumen fluid (Kilic, 2010; Kaya et al., 2011; Canbolat, 2012; Mohamoud Abdi, 2016).

Table 2 shows the in vitro true digestibility results of the forages subjected to the experiments. It can be seen that the highest IVTD value is consistently found in fresh form after 48 hours incubation, while these findings were similar to those of the pellets prepared using urea+molasses. The lowest IVTD value, on the other hand, is found from the granulated form forages (p<0.001). Digestibilities of the forages in pellet form were found to be significantly higher than that of the granulated form (p<0.001). In this study, it was found that pelleting has a positive impact on the digestibility of the forage. Although it was found that digestibility is higher for the fresh form, favorable results of pelleting were defined in terms of nutrient enrichment and other advantages of pelleting. The fact that pelleting has increased the digestibility in all groups showed that it will be suitable for SBHL to be stored in pellets using additives.

Can et al. (2003) reported in vitro DMD values of dry, urea and molasses added SBHL silages as 83.95%, 80.79% and 84.85%, respectively. In this study, the same was found to be 85.34% for the fresh material, in agreement with the literature, while the digestibility values of pelleted form SBHL forage with urea and molasses were higher than that of the literature reports. Demarquilly (1979) reported that the use of clean and soil contaminated sugar beet leaves have a significant effect on the digestibility and suggested that the DMD value of clean and fresh material is 72%, while the same is reduced to 47% when contaminated with soil. Indeed, these findings show that the method used to obtain the material has a significant impact on DMD. According to the findings of this study, it was found that pelleting has more positive effects on the digestibility of SBHL when compared to granulated forage.

4. Conclusions

In conclusion, it is observed that fresh form SBHL offers superior forage value and forage quality in terms of nutrient contents, DMD, DMI and RFV contents. It was suggested that addition of urea and molasses has positive effect on the nutrition value of SBHL as forage, and that pelleting is the best possible storage method to be used. Commonly considered as a waste, SBHL is proven to be useful in animal farming both in granulated form and pelleted form as a forage source. Moreover, it is recommended for future studies to test these findings in in vivo settings, and to observe animal performance directly.

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